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FOR RELEASE: UPON DELIVERY

Luncheon Address
by
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National Aeronautics and Space Administration
at
Conference Sponsored by
Oregon Department of Planning and Development
Portland, Oregon
May 10, 1962

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It is a great pleasure to be in Portland, to consider with you the opportunities and problems of the Space Age. It is clearer today than it has ever been that we live and work in a society and an economy where a leaping technology and a geometric progression of change make many of yesterday's landmarks carry a different meaning today; that we must, from time to time, stand back from the stream of fast-moving currents to gain perspective.

My own state, Oklahoma, is in the Southwest and you are in the Northwest, but I believe we are both fortunate because we in the West are still very near the old frontier, and it is the spirit of the frontier which is needed everywhere today to meet the problems which we all confront. The Oregon Trail and the Santa Fe Trail were both part of a common frontier.

Today's problems, created by change, must be met as pioneers have always met their problems, and this Western country has a better understanding of what it means to be a pioneer than many of the older, more-settled areas.

What is the background for today's fast-moving scene? And what does it mean to live every day with change as a constant companion? Do we have capacity to adopt innovation as a way of life?

During the first four decades of this century, research and development constituted a minor part of the stream of our national activity. During World War II, science was married to the military effort and a vast expansion of research took place. Such new things as radar and the atomic bomb required tremendous mental and physical exertion, and this introduced a new element to science, the requirement for large-scale, organized effort. Invention became the work of organized teams and vast laboratories. Since the war, from this marriage has been born a giant.

In the 12 years from 1946 to 1958, more than 50 billion dollars were spent in this country for scientific research and development by the Government, by universities, and by industry. In the four years since 1958, the years of the Space Age, more than 52 billion dollars have been spent in the Nation for research and development. At the beginning of the Space Age, in 1958, the annual level of national expenditures to acquire new scientific knowledge and to apply the knowledge that had already been accumulated amounted to between six and seven billion dollars.

Today this level has almost tripled to a level of 16 to 18 billion dollars. We have reached a point where, almost without exception, everything to which the individual must adjust himself is big, or new, or fast-moving. We have the giant corporation, mass production, mass marketing, mass communication, big government, jet transportation, new materials, and scientific management of it all.

With the advent of the rocket, the new engine which has the capacity to deliver its power both within the earth's atmosphere and out beyond the earth's atmosphere, the speed of the process of change will increase again. It is the rocket which makes it possible for man to propel himself into space, to conquer the new environment of the universe, to do useful work in this new environment, and to bring back new knowledge about the forces of nature and about the way nature is organized. And we know that much that is learned can be applied here on earth to accomplish vast improvements for the benefit of all mankind.

The rocket, this new and powerful engine, not only permits these useful activities but also provides the means for the delivery of weapons of mass destruction, almost instantaneously, anywhere in the world. Its availability, its versatility, the vast potentials which stem from the technologies associated with it, require that this Nation not expose its very existence to the risks of a second-best position in space science and technology.

Fortunately, the tremendous benefits to be gained from the vigorous and active prosecution of our space program, which is now going forward under the leadership of President Kennedy, recognizes not only the national security necessities but also the widespread economic, medical, and educational opportunities which are inherent in these new and powerful forces.

The success of our space program is dependent upon rapid advances in efficient use of energy; the development of new materials, metals, fabrics, and lubricants which can withstand wide ranges of temperature, vibration, radiation, and vacuum; the most advanced electronics; and the marriage of all of these with the life sciences.

All of these are the very forces underlying economic growth.

But there is a new situation, so new it is little understood, related to the developments of the past decade. Today, the inventions and innovations which make the best use of the advances in these new areas can come only from an intellect which has acquired a sophisticated, complete understanding of the basic laws of nature as they have unfolded at such a rapid rate.

In my view, in Oregon the heritage of the frontier spirit provides today the dimensions -- geographic, economic, social, and human -- within which the problems of the new frontier of change can best be pioneered and answers found. The new frontiers of knowledge in the physical sciences have laid a foundation for the same type of rapid advances in the life sciences. Just ahead is an understanding of the life processes, just as we now understand atomic processes.

The full development of the possibilities inherent in the application of scientific and technical advances can usher in here a period of economic growth that will bring a flowering of education and culture. Because the application of knowledge must be more sophisticated than it has been, the university, which must do research and prepare the graduate and postgraduate trained minds for this new period, must somehow find a closer relation ship with the business community. The entrepreneurial mind is in our society the means for the application of these benefits. Innovation in these new industrial-university relationships can be pioneered if the leaders of the community desire to apply foresight and participate in the development of widely shared goals.

This should be easier here, where you are not yet afflicted with pollution of air and water or with cynicism, or with the congestion that makes people get just plain tired of other people.

If the modern rocket is the instrument and symbol of space power, let us examine the way the United States is proceeding to develop this instrument and this base of power.

Of course there are a number of special military applications of the rocket which derive from military requirements and are developed under this Nation's policy of maintaining military power as a means of preventing war and letting everyone, friend and foe alike, know unmistakably that we will protect our vital interests. But beyond this, the large rockets being developed by our Nation are included in a National Launch Vehicle Program which includes ten major space boosters, from the smaller Scout to the giant Nova.

The modern rocket had its origin in the research -- largely ignored during his lifetime -- of Dr. Robert H. Goddard in the 1920's and 1930's.

Thanks to Dr. Goddard's pioneering efforts, the modern rocket, whether its fuel is a liquid or a solid chemical, does not need the oxygen of the air in order to burn, and develop tremendous thrust power. It carries its oxidizing agent with it, and thus can operate in the airless vacuum of space.

Furthermore, modern rockets do not require the atmosphere as their medium of flight support as do aircraft. In fact, rockets operate with much greater efficiency in space where they are free of the drag, turbulence, and friction-heat of the air.

These are the basic reasons why rockets can deliver the fantastic speeds we must have for sending spacecraft into earth orbits, or to the moon and beyond.

The technology required to make and fly powerful rockets, involving the most efficient use of energy, new lightweight materials, and very complex systems of electronics, had to precede the scientific work which these rockets make possible. And it follows that a large part of the work of the National Aeronautics and Space Administration today is devoted to the technology of the rocket. Therefore, a large proportion of the cost of the Nation's space program goes to design, test, build, transport, launch, keep track of, and use these advanced types of rockets.

Just as a golfer has a bag full of different clubs for shots of different distances and trajectories, we have now settled on a National Launch Vehicle Program giving us 10 different rockets. From this selection of 10 rockets, we can choose the one with the correct power and other characteristics for the mission assigned, whether to investigate conditions in space near the earth, land on the moon, or sample the atmosphere or surface of a planet.

We have gone through a difficult period when we tried many types and variations of rockets. Now, however, we are in a position to select those which show the greatest efficiency and reliability, and we can work to make them more and more reliable.

The two smallest rockets, and the four most powerful ones are the responsibility of the NASA. The four of intermediate size are adaptations of Air Force missile carriers, Thor, Atlas, and Titan.

Briefly, let me list our 10 launch vehicles in order of ascending size. Many of these names are already familiar to most of you:

Scout is a four-stage rocket, using solid propellants in all stages, that can place a satellite of 150 pounds in earth orbit. Scout will also see much use as a sounding rocket in our space sciences program.

Delta has two liquid-fuel stages and a solid-fuel stage on top. It can boost 500 pounds into orbit around the earth, and has established a fine record for reliability. Delta launched our first Orbiting Solar Observatory in March, and the four TIROS weather satellites and will orbit the experimental communications satellites Relay and Telstar. With a small stage added, Delta will be employed next year to orbit the first Syncom communications satellites, which will go into orbit at 22,300 miles and will seem to hover motionless in the sky because they will be moving at the same speed as the earth is turning.

Third in line is the Thor-Agena B whose liquid-fuel stages can boost a sixteen-hundred-pound satellite into an earth orbit. This launch vehicle should be well known here on the Pacific Coast. It has been used to launch the many Air Force Discoverer satellires, the ones which eject capsules that in many instances have been caught on the fly or recovered from the Pacific.

NASA will employ Thor-Agena B in coming months to launch the big balloon satellite, Echo II, which is 130 feet in diameter when inflated. This "satelloon" will be brighter in the evening sky and should hold its shape much longer than Echo I, which was 100 feet in diameter and which can still be seen with the unaided eye, although not as brightly as in 1960, when most of you probably watched it it sparkle like a moving star.

Fourth in line is the familiar -- and now quite dependable -- Atlas, a one-stage, liquid-fuel booster which fires the 2,700-pound Mercury space-craft into orbit.

Fifth in line is the most powerful rocket in current use, the Atlas-Agena B, which can lift 5,000 pounds in earth orbit, or it can send instrumented payloads of up to 750 pounds to the moon. Atlas-Agena B is being used currently for Ranger missions. It will also send the unmanned Mariner spacecraft toward Venus this summer, on a trajectory calculated to bring it within 25,000 miles of that planet, and will launch Nimbus, an advanced weather satellite, following our TIROS series. Nimbus will be a decided improvement over TIROS because it will keep its camera pointed at the earth continuously rather than only part of the time.

The Atlas-Agena B will also be used to launch our Orbiting Astronomical Observatory, which will take a 36-inch telescope 500 miles above the obscuring turbulence of the atmosphere, and OGO, the Orbiting Geophysical Observatory, which will carry as many as 50 scientific experiments at a time. These versatile new scientific satellites will be ready for launch in 1963 or 1964.

The Agena B, which is used as the upper stage with Thor and Atlas, is worthy of special mention in its own right. It is our leading "space engine" at present because of its multiple-start capability.

For example, when launching Ranger to the moon, the Agena B and attached spacecraft go into parking orbit around the earth. Then at the proper time, the Agena B is restarted and as it gathers speed heads off on the calculated trajectory for the moon. As I previously mentioned, we were especially pleased with the Ranger shot that hit the moon because of the accurate and predictable performance of Agena B.

When we begin rendezvous experiments next year or early in 1964, the Agena B will be fired as the target for the Gemini spacecraft to overtake in space. After the two are coupled, the Agena B will become the spacecraft's engine for further maneuvers.

Vehicle No. 6 in our National Launch Vehicle Program is also a very promising one. It is the Titan II, which is just coming into use as a military missile booster. Titan II has a new type of liquid fuel which does not "boil" away, but can be kept stored in the rocket ready to go on short notice.

Titan II can lift more than 6,000 pounds into orbit, and will be used to launch Gemini, the two-man spacecraft.

Centaur, No. 7 on our list, is an important step forward in the space program because the upper stage burns liquid hydrogen instead of kerosene and will, therefore, deliver about twice the thrust of the Agena B upper stage. The familiar Atlas will still be used as the booster, or first stage.

We have had some delays with Centaur because of difficult problems connected with this pioneering use of liquid hydrogen. We need Centaur especially for Project Surveyor, which will soft-land instruments on the moon and orbit the moon, for flights past Mars and Venus with larger spacecraft in 1964 and 1966, and for Aeros, the most advanced weather satellite now under development, which is scheduled to be placed in synchronous orbit, 22,300 miles high, in 1965.

No. 8 -- and a very lucky number for us so far -- is Saturn, which has been under development since 1958.

Saturn has a cluster of eight engines burning kerosene and liquid oxygen in the first stage and a cluster of six new-type engines burning liquid oxygen and hydrogen in the powerful second stage, which will have more than five times the thrust of Agena B, for example. We hope to flight-test the second stage for the first time next year.

Saturn will be used to put the Apollo spacecraft into earth orbit.

This is our first vehicle which will surpass the lifting power the Russians have demonstrated. Whether they are working on something as big or bigger than Saturn we do not know, but we can suppose that they are.

Saturn was first test-launched from Cape Canaveral last October. The test was highly successful and encouraging as was a second, on April 25. As one of our engineers remarked: "One success may be a miracle, but with two we start building statistics on reliability."

The eight clustered engines of Saturn's first stage generated more than one million, 300 thousand pounds of thrust at lift-off. Translated into horsepower, this is roughly equivalent to the combined top power of at least 100,000 modern automobiles.

Only the initial stage of Saturn has been tested so far. We plan to test the high-energy second stage in the summer of 1963; and late in 1964, or early in 1965, we have scheduled Saturn for boosting three astronauts into an earth orbit in a developmental model of the Apollo lunar spacecraft for the first time.

However, at least 10 Saturn flights will be made to establish full reliability before the launch vehicle is used to send astronauts aloft.

The second Saturn, by the way, stood 162 feet high, 10 feet taller than the Statue of Liberty, and weighed 463 tons at take-off.

We had a bonus experiment in this Saturn test which you may have seen on television. After the first-stage burn-out at an altitude of 65 miles, the two dummy upper stages of the rocket, loaded with 23 thousand gallons of water, were blown up on command from the ground.

The spectacular result was a disc-shaped blossom of ice particles, eight to 10 miles in diameter, and a lightning-like electrical discharge. Scientists working on this project, called Project High Water, were particularly interested in observing and analyzing the chemical and physical effects the suddenly released water had on the upper levels of the atmosphere.

No. 9 on our list is still a larger launch vehicle. Although called the <u>Advanced Saturn</u>, it will be a completely new vehicle with much more powerful engines than the present Saturn concept. Advanced Saturn has five engines in the first stage, and each of these five will produce the same thrust as all eight of the engines in the first stage of Saturn.

Advanced Saturn, when ready for operation four or five years from now, will be able to put 100 tons into earth orbit, and send more than 40 tons to the moon.

This is enough power for a flight around the moon, but not enough to launch the Apollo spacecraft, fully loaded and equipped, for a lunar landing. Two Advanced Saturns may be used for this purpose. One would orbit the spacecraft and the other would orbit its own third stage as engine for the spacecraft. The two would have to be joined in rendezvous while in orbit around the earth.

The tenth on the list is the giant among giants in our rocket field -- the <u>Nova</u>. Nova is not yet under full development, but we have made a budget request to begin all-out development in the next 12 months.

Nova will have the power to launch 175 tons into an earth orbit or 75 tons to the moon. Thus it could start Apollo off for a lunar landing by direct ascent, without reliance on the rendezvous technique.

Let me go quickly through this list again and give the weight each of our 10 launch vehicles can put into earth orbit:

Scout............	150 pounds
Delta............	500 pounds
Thor-Agena B.....	1,600 pounds
Atlas............	2,700 pounds
Atlas-Agena B....	5,000 pounds
Titan II.........	6,000 pounds
Centaur..........	8,500 pounds
Saturn...........	10 tons
Advanced Saturn..	100 tons
Nova.............	175 tons

There you are, from 150 pounds to 175 tons, and that gives you some idea of the rapid advance of space age technology,once we have a major national effort under way.

In addition to the broader goals which I mentioned earlier -- achieving security and scientific and technological leadership through progress in space exploration -- there are corollary aims which may in the long run be of as great importance. I am speaking of the practical uses which we can make of space.

We will not have to wait for the distant future to put our space technology to work. One of the dominant features of our age is the short time lag between scientific discovery and practical application.

As I have outlined, we already have some idea of the practical benefits that will come from space. They will come in three ways:

1. We will put satellites to work on a global basis to report the weather, transmit message and worldwide television programs, and to serve as electronic lighthouses in the sky.

2. In pushing our space program, we are making many technological advances which can be utilized to improve industrial processes and raise our standard of living.

3. The money we spend on space activities stimulates business in general, and industrial pioneering in particular.

I feel certain that the technological activity generated by the space program, the thinking devoted to new concepts and new ways of doing things, will permeate the entire economy.

I would like to note in passing that our vigorous push forward on the space front does not diminish activity in other sectors of research and industry. On the contrary. Progress begets progress. Concepts generated by space projects will spread throughout our society, from the classroom, to the workshop, to the boardroom. I assure you that we in NASA are doing everything humanly possible to plan and carry through a space program that will kindle this kind of enthusiasm. We are putting a team together, from astronauts to administrators, from engineers to physicists and astronomers, which can do the job.

We are in dead earnest when we say we want to give the American people something in modern terms they can be as proud of as the heroic march of the settlers who came West over the Oregon Trail, to mention but one memorable undertaking out of our people's past.

This country's greatest achievement in the space program has been the creation of a truly national effort -- as dynamic as it is urgent -- for mobilizing large resources of scientific knowledge and advanced technology to achieve clearly defined national goals. The significant fact of this decade will be more than the landing of a team of United States explorers on the moon. It will be the demonstration of the will and ability of our Nation to organize and carry out the great effort that makes such a landing possible.

In view of NASA's reliance on contractors to carry out the National Space Program, the responsibilities and opportunities for industry and the universities are obvious.

Some of the important areas requiring special attention by industry in the coming years are:

- Working with universities to educate greatly increased numbers of scientists, engineers, and technicians for roles in space exploration.

- Utilizing technical personnel effectively to minimize the time spent by highly trained specialists on routine efforts.

- Organizing teams of technical and administrative personnel in imaginative ways, both within the corporate structure and among corporations working with common objectives.

- Improving the reliability of newly developed equipment by increased emphasis on sound engineering, pride in individual workmanship, and extensive testing under conditions as near as possible to those encountered in space.

- Initiating research programs aimed at enhancing the state of art in all space activities and at modernizing facilities for fabrication and testing of components.

- Seeking to identify the new developments in space technology that can be put to work in other areas to build up our economy.

As the space program grows, the need for trained specialists will, of course, increase.

If we are to accomplish our goals within the time limits set by our national interests, our country needs greatly increased numbers of graduates in science and engineering. The commodity in most critically short supply is highly trained brainpower.

NASA is taking steps to help deal with this shortage. We have just recently announced our support of a training program at 10 universities, beginning next fall, to increase the supply of scientists and engineers who can contribute to the national space effort.

In the first year of this new program, each of the first 10 universities selected will train 10 students who are working toward their doctor's degrees. Students chosen will receive stipends of $2,400 a year for 12 months' study, and expense allowances of up to $1,000 a year. The universities will be reimbursed for tuition, fees, and other expenses involved.

We expect that this program will prove so valuable that we will want to increase it considerably in the years to come.

We have made most of the decisions, initiated most of the actions, created most of the organizational framework necessary to prepare the way to American pre-eminence in the Space Age. But no one can say with certainty today what new facilities we will need in the future, or what the impact of space exploration and associated technological advances will be on the American scene.

I want to stress again the vital importance of education, and particularly of graduate education in science and engineering, in keeping our country -- and every region of the country -- abreast of the new age of science and technology and able to take full advantage of it. Research and development -- not mass production -- is the key to almost everything we do in space.

Modern industries have tended to concentrate in regions where research facilities are best. No part of the country today can afford not to make investments in advanced scientific and engineering education and in first-class research facilities.

This is a problem, a challenge, an opportunity in regional and national development that deserves highest priorities. I know that Oregon is going to work to accept this challenge and to set its sights on full participation in pioneering on this new frontier.

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